Learning Structural Biases of Novel Verbs: An ERP Study

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Introduction

•One powerful guide to incremental language processing is verb bias, knowledge about the likelihood that a certain sentence structure co-occurs with a particular verb.

•Adults are sensitive to verb bias, measured behaviorally [1, 2, 3] and neurophysiologically [4, 5].
(1) *"The referee warned the spectators **would** get too rowdy."*
Longer reading time and larger P600 at *would*, because *warn* is likely to be followed by a direct object, rather than a sentential complement.
(2) *"Tickle the frog with the **feather**"* in an ambiguous visual world context, which contains both a frog holding a small feather and a big feather.
More fixations to target instrument at *feather*, because *tickle* is an instrument-biased verb.

•Young infants, children, and adults exploit statistical information at multiple linguistic levels [6, 7]. For verb learning In particular, linguistic distributional information supports both verb-general and verb-specific constraint learning [8, 9].

Questions

•Is adults' learning of novel verb bias dependent on structural-related or semantic-related distribution?
•What is the electrophysiological process underlying verb bias learning?

Design

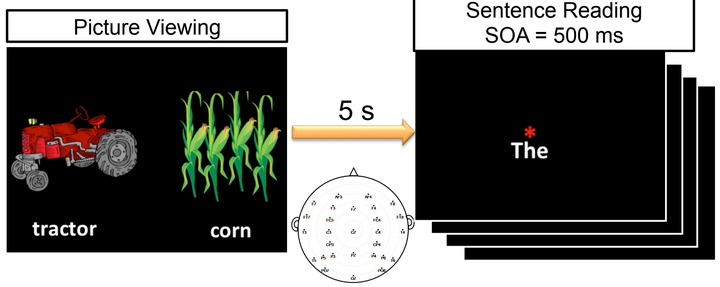
- **Materials**
  4 novel verbs: *dak, glim, norge, veeb*.
  4 sentence types: Attachment (2) X Ambiguity (2)
  2 study sessions: Block 1 & 2
  16 sentences per verb per bias condition

Attachment	Ambiguous	Unambiguous
Instrument	Verb + DO + with PP	Verb + DO + using
Modifier	Verb + DO + with PP	Verb + DO + that has

- **Stimulus Examples**
  Instrument-Ambiguous / Instrument-Unambiguous:
  The suntanned farmer dakked the corn with / using the big tractor as soon as he needed to harvest the crop.
  Modifier-Ambiguous / Modifier-Unambiguous:
  The suntanned farmer dakked the corn with / that has the high stalks as soon as he needed to use the tractor.

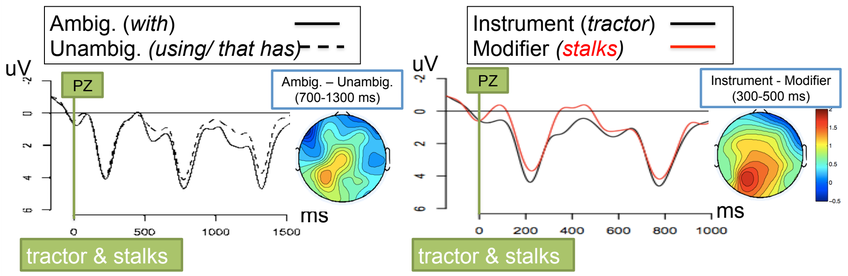
- **Participants**
  32 adults (18-22 years old; English native speakers; 16 females and 16 males)

Procedure



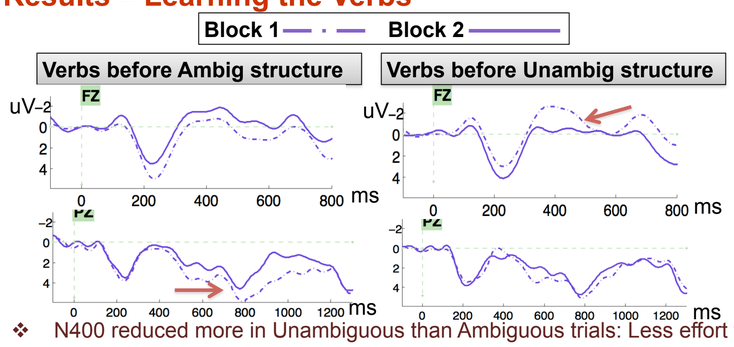
➢Picture Viewing (5 s)
Direct object of the main clause; Instrument object for instrument training (also mentioned at a non-critical position in modifier training sentences).
➢Sentence Reading: RSVP, SOA = 500 ms
➢Comprehension Questions (2.5 s)
Instrument training: How did the suntanned farmer dak the corn?
Modifier training: What did the suntanned farmer dak?
Forced Choice (4 s)
Instrument training: A. Using the tractor; B. Using the wagon.
Modifier training: A. The corn that has the high stalks; B. The corn that has the sweet taste.
➢Overall comprehension accuracy > 93%

Results – Overall



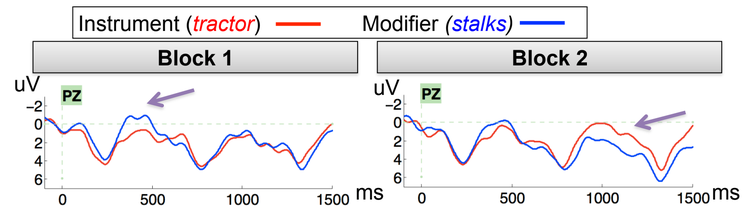
❖ Ambiguity effect: Larger P600 in Ambiguous than in Unambiguous training.
❖ Attachment effect: Smaller N400 in Instrument than Modifier training.
❖ Attachment by Ambiguity interaction: Not reliable, though reduction of N400 in instrument training is only reliable in Ambiguous but not Unambiguous trials.

Results – Learning the Verbs

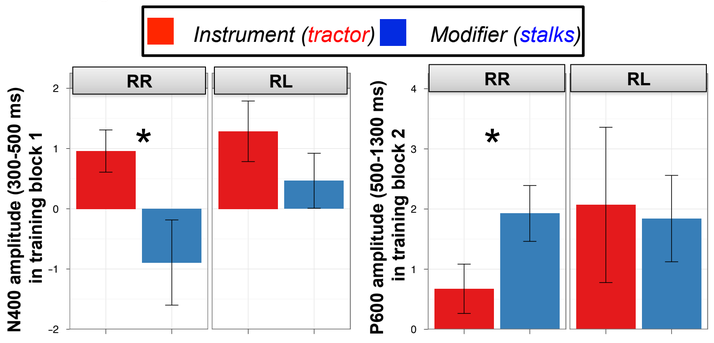


❖ N400 reduced more in Unambiguous than Ambiguous trials: Less effort to analyze novel verbs' meanings.
❖ P600 reduced more in Ambiguous than Unambiguous trials: Easier integration of the verbs with the upcoming *with* PP structure.

Results – Learning the Verb Bias



❖ The N400 effect was reduced in the second block and was followed by the emergence of a P600 response.



❖ The transition from N400 to P600 across training blocks was true only for subjects whose relatives are all right-handed (RR), but not those who have at least one left-handed relative (RL).

Conclusion

•Evidence for structural bias learning about novel verbs:
- N400 reduction in Instrument-Ambiguous training reflects the fit of the noun's meaning with the instrument role predicted based on the newly learned verb bias. No such evidence in Unambiguous condition indicates the insufficiency of semantic info for verb bias learning.
- Different block effects responding to verbs in Ambiguous and Unambiguous structures suggest verb-specific structural biases facilitated reader's processing of novel verbs.
- For right-handers with no left-handed relatives, learning verb bias involves a transition from semantic to syntactic processing.

• Experience-dependent plasticity persists in the language system, through continuous collection of statistical regularities in linguistic input.

•Future Direction
- Test subjects' explicit awareness of the trained biases
- Address when and how people use newly learned verb bias during comprehension

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